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Full Length Research Article

FUNCTIONAL, CHEMICAL AND ORGANOLEPTIC PROPERTIES OF MOI-MOI PREPARED FROM BLENDS OF COWPEA (VIGNA UNGUICULATA) AND SPROUTED PIGEON PEA (CAJANUS CAJAN) FLOURS

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ABSTRACT
Moi-moi is a steamed bean paste usually made from cowpea paste blended with seasonings and other ingredients. This study was carried out to evaluate the functional, chemical and sensory properties of moi-moi produced from cowpea and sprouted pigeon pea flour blends. Flours were produced from cowpea and sprouted pigeon pea and blended in the ratios of 100:0, 95:5, 90:10, 85:15, 80:20 and 50:50, where 100% cowpea served as the reference sample. The functional properties of the composite flours, proximate, mineral, and sensory characteristics of the moi-moi were evaluated. Functional properties ranged from 0.67 to 0.69 g/ml for bulk density, 1.33 to 1.70 ml/g for swelling index, 1.80 to 2.03 g/g for water absorption capacity, 1.27 to 1.73 for oil absorption capacity, 40.17 to 46.57 % for emulsion capacity and 30.30 to 34.00 % for foam capacity. Proximate composition results revealed that crude protein, crude fibre, and ash increased while moisture, fat and carbohydrate decreased with increased substitution of cowpea with sprouted pigeon pea. Mineral contents increased with increasing level of sprouted pigeon pea addition with values ranging from 26.30-63.37 mg/100g, 39.00-51.50 mg/100g, 272.00 to330.27 mg/100 g, 14.10 to 43.90 mg/100 g and 413.33-434.13 mg/100g for calcium, magnesium, potassium, sodium and phosphorous respectively. Sensory analysis revealed that moi-moi produced from 90% cowpea and 10% sprouted pigeon pea flour possessed the best organoleptic properties among the test samples. This study has demonstrated the production potential and nutritional benefits of sprouted pigeon pea complementation in the production moi-moi from cowpea.

Keywords: Moi-moi, cowpea, sprouted pigeon pea, blends, organoleptic properties.

INTRODUCTION

Moi-moi is a steamed bean paste usually made from cowpea paste blended with seasonings (Okwunodulu *et al*., 2019b) and other ingredients such as fish, crayfish, minced meat, bone marrow among others. Moi-moi is a well cherished food in the eastern part of Nigeria where it is used in drinking pap, soaked *garri*, and rice or eaten alone as snacks. It is also used as complementary food because of its high protein content (Okwunodulu *et al*., 2019b). Moi-moi is basically processed from cowpea (*Vigna unguiculata*), an important leguminous crop which is widely cultivated in tropical and sub-tropical countries (Kebede and Bekeko, 2020). In Nigeria, cowpea is usually referred to as beans, black eye pea, waki, etc. Cowpea plays an important role in the lives of many Africans and other developing world, where it serves as a major source of dietary protein that nutritionally complements staple low-protein cereal and tuber crops (Hussein *et al*., 2020). Cowpea also contains vitamins and minerals (Agugo *et al*., 2013). The seed has cardio-protective potency, anti-hyperglycemic and antioxidant activity (Khusniyati *et al*., 2014). Cowpea seeds can be cooked in its dried form, sprouted or ground into flour, boiled with condiments and eaten singly with stew or combined with cereals. Pigeon pea (*Cajanus cajan*) belongs to the family of *Leguminosae*. It is also known as no-eye pea (Wu *et al*., 2019). Pigeon pea is a good source of protein, fiber and minerals, making it suitable for production of protein and fiber-fortified food products (Syed and Wu, 2018). Pigeon pea is rich in minerals and water soluble vitamins (Kunyanga *et al*., 2013; Syed and Wu, 2018). Pigeon pea seeds have probiotic potential and can be used as a functional food. It is mostly consumed in the form of dhal and porridge or processed into flour for production of confectionaries.

Processing of raw food product is generally a prerequisite for improving its digestibility and palatability. The practice of sprouting is known to be associated with the improvements of the nutritive value of crops and effective in reducing some anti-nutrients and flatulence causing oligosaccharides (stachyose and raffinose), thereby increasing protein digestibility and enhancing sensory properties (Lemmens *et al*.,2018).

The immense use of cowpea for moi-moi production has led to high cost of cowpea. Pigeon pea, a cheap underutilized legume is rich in protein and has the potential of improving the quality of moi-moi when supplemented with cowpea. Moi-moi is widely consumed in Nigeria by all socioeconomic class. It's processing from flour blends of cowpea and sprouted pigeon pea seeds will not only contribute in reducing the pressure on cowpea basically used in moi-moi production but will also increase the consumption of pigeon pea, aid in reducing protein malnutrition and food insecurity in developing countries like Nigeria. The main objective of this study was to evaluate the functional, chemical and sensory properties of moi-moi prepared from blends of cowpea and sprouted pigeon pea flour.

MATERIALS AND METHODS

Sources of Raw Materials

Pigeon pea seeds and cowpea seeds and other ingredients were procured from Ubani main market in Umuahia, Abia State.

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Sample Preparation

Production of cowpea flour

The method described by Okwunodulu *et al*. (2019b) was adopted for production of cowpea flour. Cowpea seeds were sorted to remove dirt after which they were washed and steeped in tap water for 2 hours. Thereafter, the seeds were manually dehulled with the aid of hand prior to drying (in oven) at 60°C for 5 hours, milled using disc attrition mill and sieved (1mm mesh size) to obtain cowpea flour which was packaged in polyethylene bag for further use.

Production of sprouted pigeon pea flour

The method adopted by Arukwe *et al.* (2017) was used in processing of sprouted pigeon pea flour. Pigeon pea seeds were sorted to remove dirt and other foreign particles after which they were washed with tap water. The seeds were then soaked in water for 3 hours using a large container and the water drained. The soaked grains were spread in a single layer on a moistened jute bag and allowed to sprout at room temperature for 3 days. During this time, the grains were sprayed with water at intervals of 12 hours until the last day of sprouting. After sprouting, the seeds were dehulled and rootlets removed. Then the cotyledons were dried in an oven at 60°C for 7 hours and milled into flour using a disc attrition mill, sieved using 1.0 mm mesh size and packaged in polyethylene bag for further use.

Formulation of composite flour

Formulation of composite flour from blends of cowpea and sprouted pigeon pea flours is presented in Table 1.

Table 1: Formulation of cowpea-sprouted pigeon pea flour blends

Cowpea flour	Sprouted pigeon pea flour
100	0
95	5
90	10
85	15
80	20
50	50

Functional Properties Analysis

The swelling capacity, water absorption capacity (WAC), oil absorption capacity (OAC), foam capacity (FC) and bulk density (BD) were determined with the methods described by Onwuka (2018).

Production of Moi-moi

Moi-moi samples from cowpea and sprouted pigeon pea flour blends were processed using the formulation in Table 1. Moi-moi made with 100% cowpea flour served as the control. The flour blends (500g) were mixed with hot water (600 ml) and seasoned with 50 ml of vegetable oil, 25g of ground crayfish, 25 g of onion, 25 g of tomato sauce, 10 g of pepper, 5 g of salt and 40.15 g of maggi cube. Thereafter, they were mixed until a homogenous slurry was obtained. The paste was then wrapped in already washed "Etere" leaf (*Thaumatococcus danielli*) and steamed in a covered pot for 50 minutes using a gas cooker. After steaming it was allowed to cool to room temperature before analyses were carried out.

Proximate Composition Analysis

Protein, crude fibre, moisture, ash, fat and carbohydrate contents of the moi-moi were determined by the official methods of AOAC (2010).

Mineral Analysis

The method described by AOAC (2010) was employed to determine the calcium, magnesium, phosphorus, potassium and sodium contents of the moi-moi.

Evaluation of Sensory Properties of the Moi-moi

The sensory evaluation of the moi-moi samples was carried out according to the method described by Iwe (2014). A total of 20 trained and untrained panelists performed the sensory test to determine the appearance, taste, mouth-feel, texture and general acceptability of the moi-moi samples on 9-point Hedonic scale (1 = dislike extremely and 9 = like extremely). The coded moi-moi samples were presented to the panelists on a tray in individual booths to avoid bias. A questionnaire describing the quality attributes of the moi-moi samples was given to each panelist. The panelists were provided with portable water to rinse their mouth after each evaluation.

Experimental Design

Completely randomized design (CRD) was used in this study.

Statistical Analysis

Data was subjected to Analysis of Variance (ANOVA) using the Statistical Product for Service Solution (SPSS) version 21.0 while mean separation was done using Duncan Multiple Range Test (DMRT) at 95% confidence level.

RESULTS

Functional Properties of Cowpea-Sprouted Pigeon Pea Flours

The results of functional properties of the composite flours are shown in Table 2. The bulk density (BD) ranged from 0.67 to 0.69 g/ml and significant ($p \leq 0.05$) difference existed among the samples. The highest BD (0.69 g/mL) was recorded in sample A while samples E and F had the lowest BD (0.67 g/mL). The BD reduced with increased addition of sprouted pigeon pea flour in the blend. The BD obtained in this study is lower than 0.71 to 0.76 g/mL reported by Arukwe *et al.* (2022) for mungbean-cooking banana composite flour. There were significant ($p \leq 0.05$) differences in the swelling index of the flour samples. Increasing the substitution of sprouted pigeon pea flour resulted to the increase in the swelling index such that as the substitution of sprouted pigeon pea flour increased from 5% to 50%, the swelling index increased from 1.33 to 1.70 mL/g. The water absorption capacity (WAC) ranged between 1.80 g/mL to 2.03 g/mL and differed significantly ($p \leq 0.05$) among the samples. The oil absorption capacity (OAC) ranged from 1.27 to 1.73 g/mL and the values showed significant differences. Emulsion capacity of the flour samples ranged from 40.17 to 46.57% with significant ($p \leq 0.05$) differences among the flour samples. Sample A had the highest emulsion capacity while sample F had the lowest value. The emulsion capacity decreased

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as the substitution of cowpea with sprouted pigeon pea flour increased in the composite flours. The foaming capacity (FC) of the flours ranged from 30.30 to 34.00 %. Sample F had the highest value while sample A had the lowest value with significant ($p \leq 0.05$) differences existing among the samples.

Table 2: Functional properties of cowpea-sprouted pigeon pea composite flour samples

Sample	BD (g/ml)	Swelling index (ml/g)	WAC (g/g)	OAC (g/g)	EC (%)	FC (%)
A	$0.69^{a}\pm0.02$	$1.33^{d}\pm0.06$	$1.80^{c}\pm0.01$	$1.27^{c}\pm0.01$	$46.57^{a}\pm0.33$	$30.30^{c}\pm0.21$
B	$0.68^{a}\pm0.01$	$1.47^{c}\pm0.06$	$1.87^{bc}\pm0.06$	$1.37^{c}\pm0.06$	$46.00^{a}\pm0.21$	$32.37^{b}\pm0.21$
C	$0.68^{b}\pm0.02$	$1.53^{bc}\pm0.06$	$1.90^{abc}\pm0.10$	$1.53^{b}\pm0.01$	$43.83^{b}\pm0.23$	$32.73^{ab}\pm0.21$
D	$0.68^{b}\pm0.03$	$1.57^{bc}\pm0.06$	$1.97^{ab}\pm0.06$	$1.60^{ab}\pm0.06$	$43.33^{b}\pm0.21$	$33.22^{ab}\pm0.21$
E	$0.67^{c}\pm0.02$	$1.63^{ab}\pm0.06$	$2.00^{ab}\pm0.10$	$1.67^{ab}\pm0.06$	$41.67^{c}\pm0.44$	$33.48^{ab}\pm0.41$
F	$0.67^{d}\pm0.02$	$1.70^{a}\pm0.10$	$2.03^{a}\pm0.12$	$1.73^{a}\pm0.12$	$40.17^{d}\pm0.02$	$34.00^{a}\pm0.02$

a-f: Values are means +standard deviation of duplicate determination. Mean values in the same column with different superscript are significantly different ($p<0.05$). BD= Bulk Density, WAC-Water Absorption Capacity, OAC=Oil Absorption Capacity, EC=Emulsion Capacity and FC=Foam Capacity. A= 100% Cowpea. B= 95% cowpea: 5% sprouted pigeon pea. C= 90% cowpea: 10% sprouted pigeon pea. D= 85% cowpea: 15% sprouted pigeon pea. E= 80% cowpea:20% sprouted pigeon pea. F= 50% cowpea:50% sprouted pigeon pea

Proximate Composition of Moi-moi from Cowpea-Sprouted Pigeon Pea Flours

The results of proximate composition of the moi-moi are presented in Table 3. The moisture content of the moi-moi ranged from 28.32% to 29.81% with sample A (control) recording the highest value which significantly ($p \leq 0.05$) decreased with inclusion of sprouted pigeon pea flour. Sample F had the least moisture content (28.32%). The crude protein content of the moi-moi ranged from 12.12 to 13.36%. Samples A and F had the lowest and highest protein content respectively. The fat content of the samples reduced with increase in supplementation with sprouted pigeon pea. Crude fibre ranged from 2.43% to 3.79%. Sample A had the lowest value while sample F had the highest value and they showed significant ($p \leq 0.05$) differences. The result obtained in this study for crude fibre was higher than the range (1.38 % - 1.85 %) reported by Akusu and Kiin-Kabari (2012) for moi-moi prepared from cowpea and maize flour blends. The ash content ranged between 3.21% and 3.83% with significant ($p \leq 0.05$) differences existing among the samples. The ash content progressively increased with the increase in sprouted pigeon pea flour addition. The carbohydrate content of the moi-moi samples ranged from 44.64% to 46.32% with significant ($p \leq 0.05$) differences existing among the samples. The carbohydrate content of the samples decreased as the substitution of cowpea flour with sprouted pigeon pea flour increased.

Table 3: Proximate content of moi-moi from cowpea-sprouted pigeon pea flours

Samples	Moisture (%)	Crude Protein (%)	Fat (%)	Crude Fibre (%)	Ash (%)	CHO (%)
A	$29.81^{a}\pm0.43$	$12.12^{f}\pm0.10$	$6.11^{a}\pm0.02$	$2.43^{e}\pm0.03$	$3.21^{f}\pm0.02$	$46.32^{a}\pm0.32$
B	$29.59^{b}\pm0.52$	$12.54^{e}\pm0.18$	$6.11^{a}\pm0.02$	$2.47^{d}\pm0.06$	$3.26^{e}\pm0.03$	$46.03^{b}\pm0.38$
C	$29.09^{c}\pm1.42$	$12.60^{d}\pm0.10$	$6.10^{b}\pm0.02$	$3.03^{c}\pm0.10$	$3.31^{d}\pm0.03$	$45.87^{c}\pm0.29$
D	$29.00^{d}\pm0.12$	$12.83^{c}\pm0.10$	$6.09^{b}\pm0.02$	$3.07^{c}\pm0.08$	$3.41^{c}\pm0.02$	$45.69^{d}\pm0.20$
E	$28.48^{d}\pm0.40$	$13.01^{b}\pm0.10$	$6.08^{c}\pm0.07$	$3.28^{b}\pm0.04$	$3.54^{b}\pm0.40$	$45.61^{d}\pm5.43$
F	$28.32^{e}\pm0.12$	$13.36^{a}\pm0.10$	$6.06^{c}\pm0.09$	$3.79^{a}\pm0.05$	$3.83^{a}\pm0.06$	$44.64^{e}\pm0.15$

a-f: Values are means +standard deviation of duplicate determination. Mean values in the same column with different superscript are significantly different ($p<0.05$).A= 100% Cowpea. B= 95% cowpea: 5% sprouted pigeon pea. C= 90% cowpea: 10% sprouted pigeon pea. D= 85% cowpea: 15% sprouted pigeon pea. E= 80% cowpea:20% sprouted pigeon pea. F= 50% cowpea:50% sprouted pigeon pea.

Mineral Content of the Moi-moi from Cowpea-Sprouted Pigeon Pea Flours

The results of mineral composition are presented in Table 4. The calcium content of the moi-moi samples ranged from 26.30 to 63.37 mg/100 g. There was significant ($p \leq 0.05$) difference among the samples. Sample A had the lowest value while sample F had the highest value. The values obtained in this study are higher than the values (12.10-19.10 mg/100 g) reported by Ejima and Ejima (2015) for maize, improved maize and beans moi-moi. Magnesium content ranged from 39.00 to 51.50 mg/100 g with significant ($p \leq 0.05$) differences existing among the samples. The magnesium content of the samples increased with increasing level of sprouted pigeon pea substitution such that at 5% - 50% complementation levels, the magnesium contents increased steadily from 39.00 to 51.50 mg/100 g, and higher than the values (8.00 mg/100 g - 9.20 mg/100 g) reported by Ejima and Ejima (2015) for moi-moi produced from maize and beans. The potassium content ranged between 272.00 mg/100 g and 330.27 mg/100 g with samples A and F recording the least and highest values respectively. The sodium content of the samples was affected by blending cowpea and sprouted pigeon pea. Sodium content ranged from 14.10 to 17.50 mg/100 g. Sample A had the lowest sample while sample F had the highest value. The values of phosphorous ranged between 413.33 mg/100g to 434.13 mg/100g. The incorporation of sprouted pigeon pea flour improved the phosphorous content of the samples. Notably, as the level of pigeon pea flour addition increased, the level of phosphorous content also increased.

Table 4: Mineral content of moi-moi from cowpea-sprouted pigeon pea flours (mg/100 g)

Samples	Calcium	Magnesium	Potassium	Sodium	Phosphorus
A	$26.30^{e}\pm1.56$	$39.00^{d}\pm0.21$	$272.00^{c}\pm4.58$	$14.10^{f}\pm1.00$	$413.33^{b}\pm6.81$
B	$27.70^{e}\pm0.69$	$40.20^{cd}\pm1.39$	$279.33^{bc}\pm2.89$	$14.87^{e}\pm0.46$	$418.00^{bc}\pm4.00$
C	$39.03^{d}\pm0.38$	$42.17^{bcd}\pm0.23$	$288.33^{bc}\pm2.52$	$15.13^{d}\pm0.46$	$422.20^{b}\pm0.72$
D	$49.10^{c}\pm0.44$	$43.20^{bc}\pm0.53$	$291.67^{b}\pm2.52$	$16.31^{c}\pm0.76$	$423.23^{b}\pm4.38$
E	$54.00^{b}\pm0.87$	$44.17^{b}\pm0.60$	$318.33^{a}\pm21.94$	$16.77^{b}\pm1.67$	$425.47^{b}\pm3.11$
F	$63.37^{a}\pm2.11$	$51.50^{a}\pm4.26$	$330.27^{a}\pm1.96$	$17.50^{a}\pm0.17$	$434.13^{a}\pm1.63$

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a-f: Values are means ±standard deviation of duplicate determination. Mean values in the same column with different superscript are significantly different (p<0.05).A= 100% Cowpea. B= 95% cowpea: 5% sprouted pigeon pea. C= 90% cowpea: 10% sprouted pigeon pea. D=85% cowpea: 15% sprouted pigeon pea. E=80% cowpea:20% sprouted pigeon pea. F=50% cowpea:50% sprouted pigeon pea

Sensory Properties of Moi-moi from Cowpea-Sprouted Pigeon Pea Flours

The results of sensory characteristics of the moi-moi samples are presented in Table 5. The appearance of the moi-moi samples ranged from 6.47 to 7.75. The results showed that sample B had the highest rating while sample F had the lowest rating. The scores for appearance of the samples decreased with increasing complementation of sprouted pigeon pea flour. The scores for taste ranged from 5.50 to 7.54. Sample A had the highest scores while sample F had the lowest score. The scores for taste differed significantly (p≤0.05) for all the samples except samples B and C which were similar. The scores for taste decreased as sprouted pigeon pea flour addition increased.

Table 5: Sensory characteristics of moi-moi from cowpea-sprouted pigeon pea flours

Samples	Appearance	Taste	Mouth Feel	Texture	General Acceptability
A	$7.51^{b}±0.03$	$7.70^{a}±0.12$	$7.38^{a}±0.72$	$7.59^{a}±0.14$	$7.77^{a}±0.23$
B	$7.75^{a}±0.30$	$7.60^{b}±0.45$	$7.37^{b}±0.03$	$7.53^{a}±0.05$	$7.45^{c}±0.20$
C	$7.50^{b}±0.49$	$7.54^{b}±0.24$	$7.13^{b}±0.33$	$7.26^{b}±0.10$	$7.63^{b}±0.08$
D	$6.75^{d}±0.41$	$6.34^{c}±0.09$	$7.10^{b}±0.37$	$7.25^{b}±0.10$	$6.78^{d}±0.02$
E	$6.81^{c}±0.18$	$6.13^{d}±0.10$	$6.35^{c}±0.05$	$6.78^{c}±0.07$	$6.41^{e}±0.04$
F	$6.47^{e}±0.27$	$5.50^{e}±0.26$	$5.57^{d}±0.47$	$5.64^{d}±0.09$	$6.31^{f}±0.58$

a-f: Values are means ±standard deviation of duplicate determination. Mean values in the same column with different superscript are significantly different (p<0.05).A= 100% Cowpea. B= 95% cowpea: 5% sprouted pigeon pea. C= 90% cowpea: 10% sprouted pigeon pea. D= 85% cowpea: 15% sprouted pigeon pea. E=80%cowpea:20%sproutedpigeonpea.
F= 50%cowpea:50%sproutedpigeonpea

Mouth feel scores of the moi-moi samples ranged from 5.57 to 7.38 with significant (p≤0.05) differences existing among them. Moi-moi produced from 100% cowpea had the highest score for mouth feel while moi-moi containing 50% cowpea had the lowest rating, which suggested that samples containing sprouted pigeon pea flour were less preferred when compared to the control. Texture scores were found to be highest for sample A (7.59) which was not significantly (p≤0.05) different from sample B as rated by the panelists. Notably, the texture scores of the moi-moi samples depreciated with sprouted pigeon pea flour inclusion. The scores for general acceptability showed that 100% cowpea flour (sample A) was most preferred in the production of moi-moi with a mean score of 7.77 followed by sample C (90 cowpea: 10 sprouted pigeon pea) with a mean score of 7.63.

DISCUSSION

It was observed in this study that increasing the addition of sprouted pigeon pea flour led to a decrease in the bulk density (BD) of the composite flours. This could be due to the fact that sprouting causes reduction in bulk density (Onimawo and Akubor, 2005) and the increasing addition of the sprouted pigeon pea flours reduced the bulk densities of the samples. This result is in consonance with the findings of Arukwe *et al*. (2022) who reported that bulk density of composite flour decreased with an increase in the incorporation of cooking banana to mungbean flour. Low BD would be beneficial in the formulation of weaning foods (Ezeocha and Onwuka, 2010). The results of swelling power indicated that the composite flours caused slight aggregation of starch granules to different degrees and subsequently affected the level of its exposure to water and its swelling power. The high swelling index in sample F (50% cowpea:50% sprouted pigeon pea flour) implies that it could be useful in food systems such as spaghetti, noodles, etc., where swelling is required. The water absorption capacity (WAC) of the flour blends increased with increasing proportions of sprouted pigeon pea flour, which suggest that, sprouted pigeon pea flour may be rich in hydrophilic protein. Butt and Batool (2010) reported that protein possess both hydrophilic and hydrophobic properties which enables its association with moisture in foods. The WAC values obtained in this study (1.33 to 1.70 ml/g) were higher than the values (1.20 to 1.25 g/ml) reported by Arukwe *et al.* (2022) but lower than (2.077 to 2.406%) reported by Arukwe *et al.* (2017). The slight increase in oil absorption capacity with the increased inclusion of sprouted pigeon pea flour observed in this study indicates that the samples will be useful in food applications, such as in bakery products, where flavour retention and improvement of palatability is required. The low OAC of the flour blends might be beneficial in preventing rancidity and extending shelf life of products. The emulsion capacity decreased as the substitution of cowpea with sprouted pigeon pea flour increased in the composite flours. Decreasing emulsion capacity as the proportion of sprouted pigeon pea flours increased suggest the dilution of rigid globular protein which may be present in cowpea flour. Despite the decreasing emulsion capacity of the flours, all composite flours showed relatively good capacity of emulsion activity. The increase in foam capacity observed with increased inclusion of sprouted pigeon pea flour showed that the different proportions of the flours may have affected the flexibility of the protein molecules differently. Foams are used to improve texture, consistency and appearance of foods (Akubor and Badifu, 2014). The values obtained in this study are lower than 60% and 80% reported for wheat flour and African breadfruit kernel flour respectively (Akubor and Badifu, 2014). Good foam capacity is a desirable quality for flours used for the production of various products such as cakes, sponges, ice creams, marshmallows, whipped creams, and bread (Atuonwu and Akobundu, 2010). However, food ingredients with low foaming capacity may suitably be applied in biscuits, crackers, and cookies (Borja *et al.,* 2013).

The proximate results showed that complementing cowpea flour with sprouted pigeon pea flour samples significantly reduced the moisture content of the samples and this implies increased shelf stability of the moi-moi samples. However, the moisture contents of the produced moi-moi samples were high, which indicates low dry matter content (Adepoju and Etukumoh, 2014), thus, it is not advisable to keep this product for a long time prior to consumption. The moisture contents of the samples were above 10% which

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suggest increased chances of spoilage by microorganisms and consequently reduced shelf life (Ariahu *et al.,* 1999) at ambient temperature (Offor, 2015). The result also revealed that the crude protein, crude fibre and ash content of the samples followed the same trend as they progressively increased with increasing level of sprouted pigeon pea flour complementation. This result shows that pigeon pea is a source of these nutrients. Also, sprouting has been reported to enrich the nutritional profile of legumes and other crops by reducing the concentration of antioxidant and increasing the bioavailability of nutrient (Egounlety *et al*., 2002). Hence, the increasing protein content of composite moi-moi samples associated with increasing proportion of sprouted pigeon pea may be due to the sprouting process. Furthermore, the increased protein content of the composite moi-moi might contribute significantly towards combating protein energy malnutrition. Protein plays vital role in enzymatic catalysis, transport and storage of molecules, immune protection, generation and transmission of nerve impulse, control of growth and differentiation. The crude fibre results obtained in this study increased with increasing level of sprouted pigeon pea substitution and this implies that pigeon pea is rich in fibre and the sprouting process also enhanced the fibre content (Nwanekezi *et al*., 2017; Arukwe *et al*., 2022b). Dietary fibres are indigestible and unabsorbed in the body. They provide bulk to the gut which stimulates peristalsis and results in shorter passage time and more frequent defecation (Ojo *et al.,* 2014). It acts to lower the concentration of low-density lipoprotein cholesterol in the blood, possibly by binding with bile's acids (Ishiwu and Tope, 2015). The fat content significantly ($p \leq 0.05$) reduced with increase in sprouted pigeon pea inclusion. The low fat content of the samples may result to increased keeping quality due to reduced susceptibility to rancidity (Ikujenlola *et al*., 2013). However, the samples may have reduced capability of serving as a viable vehicle for fat soluble vitamins transport as well as improving mouth-feel and palatability that fat provides compared to the control sample (Coppin and Pike, 2011). The complementation of sprouted pigeon pea in increasing order resulted to a corresponding increase in the ash content of the samples. Pigeon pea has been reported to be a good source of minerals such as phosphorus, magnesium, iron, calcium, sulphur and potassium but low in sodium (Kunyanga *et al*., 2013, Arukwe, 2020). Ash content represents total minerals content in foods and thus, serves as a viable tool for nutritional evaluation of mineral (Lienel, 2002).
The carbohydrate (CHO) content decreased with increased substitution of sprouted pigeon pea in the blends. The CHO values (44.64% to 46.32%) were higher than the values (15.87% - 34.72%) obtained by Akusu and Kiin-Kabari (2012) for moi-moi produced from cowpea and soybean.

The mineral content of the moi-moi samples showed significant increase with inclusion of sprouted pigeon pea flour to cowpea flour in the production of moi-moi. The results revealed that calcium, magnesium, potassium, sodium and phosphorus followed the same trend of increase with rise in supplementation of cowpea with sprouted pigeon pea. This suggests that sprouting increased the mineral content in pigeon pea and consequently, the moi-moi samples. Calcium is important in the body as it helps in the building and maintenance of teeth and it plays a key role in our cells. Calcium is necessary for growth and helps in calcification of strong bones for optimal growth and development (Parr *et al.,* 2012). The increased magnesium content of the moi-moi is beneficial since magnesium is a cofactor in more than 300 enzyme systems that regulate diverse biochemical reactions in the body, including protein synthesis, muscle and nerve function, blood glucose control, and blood pressure regulation (Aydin *et al.,* 2010). Magnesium is an essential component of all cells and is necessary for the functioning of enzymes involved in energy utilization and it is present in the bone (Ayuk *et al.,* 2019). The increase in potassium content as the proportion of sprouted pigeon pea increased in the blends indicates the significance of sprouting and the high potassium content of pigeon pea. Potassium is necessary for the normal functioning of all cells. It regulates the heart beat and ensures proper functioning of the muscles and nerves. However excessive intake of potassium may upset homeostatic balance and cause toxic side effects (Parr *et al.,* 2012). The sodium content increased with increasing proportion of sprouted pigeon pea in the moi-moi, but the sodium content of the moi-moi samples are quite low compared to the WHO recommendation. The values obtained are < 2 g/day sodium (5g/day salt) in adults recommended by WHO (2018). The low sodium content is advantageous since low sodium diet has been reported to be beneficial in the prevention of high blood pressure (Onwuka, 2018). It was observed that as the level of pigeon pea addition increased, the level of phosphorous content also increased. This implies that the composite samples could provide valuable nutrient for bone formation. Phosphorus works closely with calcium to build strong bones and teeth as they combine to form calcium phosphate, the predominant mineral of bone.

The sensory evaluation results showed that complementation of cowpea with sprouted pigeon pea for the production of moi-moi caused a decrease in all the parameters assessed. The decrease may be attributed to the non-familiarity of pigeon pea use in moi-moi which affected the rating. However, all the samples were generally accepted judging from the 9-point hedonic scale, but the moi-moi sample produced from 90 cowpea:10 sprouted pigeon pea was preferred among the test samples.

Conclusion
This study has demonstrated the potential of cowpea and sprouted pigeon pea in the production of moi-moi. The proximate analysis showed that, increasing level of sprouted pigeon pea substitution resulted to an increase in the amount of crude protein, crude fibre, and ash of the moi-moi samples and reduction in moisture, fat and carbohydrate contents. From the mineral analysis, phosphorous was found to be the most abundant mineral present in the samples followed by potassium. The mineral contents were positively enhanced with the inclusion of sprouted pigeon pea. Sensory analysis revealed that moi-moi produced from 90% cowpea and 10% sprouted pigeon pea was preferred among the test samples by the panelists. The substitution of cowpea with sprouted pigeon pea in moi-moi preparation is recommended to reduce pressure on cowpea, create varieties, boost pigeon pea farming, and improve food security in Nigeria.

REFERENCES
Adepoju, O.T. and Etukumoh, A.U. (2014). Nutrient composition and suitability of four commonly used local complementary foods in Akwa Ibom State, Nigeria. *African Journal of Food, Agriculture, Nutrition and Development*. 14(7): 9544-9560.
Agugo, U. A., Okereke, T. O. and Anya, K. M. (2013). Investigating the nutrient composition and anti-nutritional factors of *Akidi* (*Vigna unguiculata*). *International Organization of Scientific*

DOI: https://dx.doi.org/10.4314/swj.v18i3.17

Research, 5(4): 32-35.

Akubor, P.I. and Badifu, G.I.O. (2014). Chemical composition, functional properties and baking potential of African pear *(Dacroydes edulis)* flour. Research Journal of Medicinal Plants, 4:30-39.

Akusu, O. M. and Kiin-Kabari, D. B. (2012). Protein quality and sensory evaluation of moin-moin prepared from cowpea/maize flour blends. *African Journal of Food Science*. 6(3):47-51.

Ariahu, C. C., Ukpabi, U. and Mbajunwa, K. O. (1999). Production of African breadfruit (*Treculia africana*) and soybean (*Glycine max*) seed based food formulation: Effect of germination and fermentation on nutritional and organoleptic quality. Plant Foods Human Nutr., 54:193-206.

AOAC (2010). Official Method of Analysis. 18th Edition. Association of Official Analytical Chemists, Washington DC, USA.

Arukwe, D. C. (2020). Proximate composition, physical properties and sensory evaluation of wheat-cocoyam-pigeon pea biscuits. *IOSR Journal of Environmental Science, Toxicology and Food Technology*, 14(7): 47-51.

Arukwe, D. C. (2021). Proximate composition, functional and pasting properties of wheat flour supplemented with combined processed pigeon pea flour. *International Journal of Food Science and Nutrition*, 6(4): 59-64.

Arukwe, D. C., Nwanekezi, E. C. and Agomuo, J. K. (2017). Effect of combined processing methods on the functional and pasting properties of pigeon pea (*Cajanus cajan*) flour. *International Journal of Science and Qualitative Analysis,* 3(3): 23-30.

Arukwe, D. C., Offia Olua, B. I. and Nduka, J. (2022). Evaluation of the proximate composition, functional and sensory properties of mungbean-cooking banana composite flours and biscuits. *Uniuyo Journal of Gender Studies*, 4: 148-164.

Arukwe, D. C., Offia Olua, B. I. and Ike, E. A. (2022b). Proximate composition, functional properties and sensory attributes of gruels prepared from blends of sorghum and pigeon pea flours. International *Journal of Home Economics, Hospitality and Allied Research*, 1(2): 361-375.

Atuonwu, A. C. and Akobundu, E. N. (2010). Functional and pasting properties of pumpkin (*Cucurbita pepo*). Journal of Agricultural and Veterinary Science, 2: 36–49.

Aydin, S., Croteau, G., Sahin, I. and Citil, C. (2010). Ghrelin, Nitrite and paraoxonase/Arylesterase concentrations in cement plant worker. *Journal of Medical Biochemistry*, 29-2:78-83.

Ayuk, E. T., Duguma, B., Kengue, J., Tiki–managa, T., Zekkeng, P. (2019). Uses, management and economic potential of African pear *(Dacroydes edulis)* in human low-land Cameroon. Economic Botany, 53 (3): 292-300.

Borja, R., Ukhun, M.E. and Ukpebor, U.I.E. (2013). Production of instant flour: Sensory evaluation and physiochemical changes during storage. *Food Chemistry*, 42:287-299.

Butt, M. S. and Batool, R. (2010). Nutritional and functional properties of some promising legume proteins isolates. *Pakistan Journal of Nutrition*, 9(4):373–379.

Coppin, E. A. and Pike, O. A. (2001). Oil stability index correlated with sensory determination of oxidative stability in light-exposed soybean oil. *Journal of American Oil Chemists Societ.,* 78: 13-18.

Egounlety, M., Aworh, O. C., Akingbala, J. O., Houben, J. H. and Nago, M. C. (2002). Nutritional and sensory evaluation of tempeh fortified maize based weaning foods. *International Journal of Food Science and Nutrition,* 53:15-27.

Ejima, O. A. W. and Ejima, O. S. (2015). Nutrient potential of improved fresh maize *Moi-moi* compared bean *Moi-moi International Journal of Innovative Sciences, Engineering and Technology,* 2(6): 559-572.

Ezeocha, V. C. and Onwuka, G. I. (2010). Effect of processing methods on the physicochemical and nutritional quality of maize and soybean based complimentary blends. *Nigerian Food Journal*, 28 (2): 210-216.

Hussein, J. B., Ilesanmi, J. O. Y., Aliyu, H. M. and Akogwu, V. (2020). Chemical and sensory qualities of moi-moi and *akara* produced from blends of cowpea (*Vigna unguiculata*) and *Moringa* oleifera seed flour. *Nigeria Journal of Technological Research*, 15(3):15-23.

Ikujenola, A.V., Oguntuase, S.O., Omosuli, S.V. (2013). Physico-chemical properties of complementary food from malted quality protein maize and defatted fluted pumpkin flour. *Food and Public Health*. 3(6): 323-328.

Ishiwu, C. N. and Tope, V. A. (2015). Effect of period of fermentation on nutrients of castor oil seed (*Ricinus communis*). *Direct Research Journal of Agriculture and Food Science*, 3(10): 178-183

Iwe, M. O. (2014). Current Trends in Sensory Evaluation of Foods. Revised Edition. Rojoint Communication Services Ltd. Uwani Enugu, Nigeria, 144-145.

Kebede, E. and Bekeko, Z. (2020). Expounding the production and importance of cowpea (Vigna unguiculata (L.) Walp.) in Ethiopia. *Cogent Food and Agriculture*, 6(1): 176.

Khusniyati, E., Sari, A. A., Yueniwati, Y., Noorhamdani, N., Nurseta, T. and Keman, K. (2014). The effects of *Vigna unguiculata* on cardiac oxidative stress and arota estrogen receptor-B expression of ovariectomized rats. *Asian Pacific Journal of Reproduction*, 3(4): 263-267.

Kunyanga, C., Imungi, J. and Vellingiri, V. (2013). Nutritional evaluation of indigenous foods with potential food-based solution to alleviate hunger and malnutrition in Kenya. *Journal of Applied Biosciences,* 67: 5277-5288.

Lemmens, E., Moroni, A. V., Pagand, J., Heirbaut, P., Ritala, A., Karlen, Y., Le, K., Broeck, H. C. V., Brouns, F. J. P H., Brier, N. D. and Delcour, J. A. (2018). Impact of cereal seed sprouting on its nutritional and technological properties: a critical review. *Comprehensive Reviews in Food Science and Food Safety,* 18(1): 1-15.

Nwanekezi, E. C., Ubbaonu, C. N. and Arukwe, D. C. (2017). Effect of combined processing methods on proximate and mineral composition of pigeon pea (*Cajanus cajan*) flour. *International Journal of Food Science and Biotechnology*, 2:73-79.

Offor, C. E. (2015). Determination of vitamin composition of *Dissotis rotundifolia* leaves. *Int. J. Curr. Microbiology and Applied Sci*., 4(1): 211.

Ojo, A., Abiodun, O. A., Odedeji, J. O. and Akintoyese, O. A. (2014). Effects of drying methods on proximate and physico-chemical properties of fufu flour fortified with soybean. *British Journal of Applied Science and Technology*, 4(14), 2079-2089

Okwunodulu, I. N., Peter, G. C. and Okwunodulu, F. U. (2019b). Proximate quantification and sensory assessment of moi-moi prepared from bambara nut and cowpea flour blends. *Asian Food Science Journal*, 9(2): 1-11.

DOI: https://dx.doi.org/10.4314/swj.v18i3.17

Onimawo, A. I. and Akubor, P. I. (2005). Food Chemistry. Ambik Press Limited Benin City, Edo State, Nigeria. Pp. 222-228.

Onwuka, G. I. (2018). Food Analysis and Instrumentation. Theory and Practice. Second Edition. Naphtali Prints Lagos, Nigeria, 10-20

Parr, R. M., Crawley, H., Abdulla, M., Iyengar, G. V. and Kumpulainan, J. (2012). Human dietary intakes of trace elements. A global literature survey mainly for the period1970-1991.ReportNAHRES. Vienna. International Atomic Energy Agency.

Syed, R. and Wu, Y. (2018). A review article on health benefits of pigeon pea (*Cajanus cajan* (L.) Millsp). *International Journal of Food and Nutrition Research*, 2(15): 1-17.

WHO. (2018). The Changes in quality characteristics of food during microwave drying. Drying Technology, 27(7): 857–862.

Wu, N., Fu, K., Fu, Y. J., Zu, Y. G., Chang, F. R., Chen, Y. H., Liu, X. L., Kong, Y., Liu, W. and Gu, C. B. (2019). Antioxidant activities of extracts and main components of pigeon pea [*Cajanus cajan* (L.) Millsp.] leaves. *Molecules*, 14(3):1032-1043.